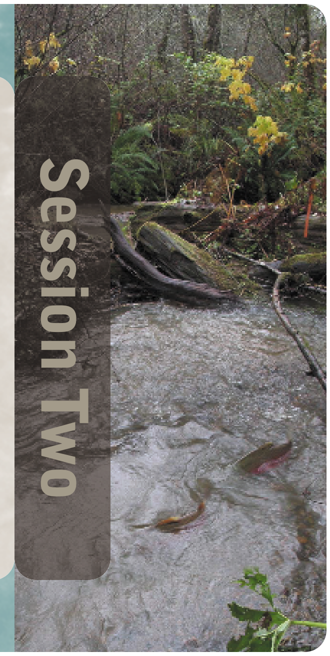
Road maintenance, road decommissioning, and stream crossing upgrades

Forestland Crossings: Assessment and Costs

MIKE JANI
Mendocino Redwood Company
PO Box 390
Calpella, CA 95418
mjani@mendoco.com



ABSTRACT

This paper presents the viewpoint of the practitioner on private land who is assessing and repairing stream crossings on forestland.

INTRODUCTION

The 235,000 acres of the Mendocino Redwood Company lands are located mainly in Mendocino County, California, with some acres in Sonoma County. A former holding of Louisiana Pacific Corporation, it was recently purchased by a private family and is now a small family-run operation. This ownership provides a great deal of latitude for what occurs on the land.

The Mendocino Redwood Company program starts with assessment and a systematic road inventory. As part of that inventory, we use Global Positioning Systems (GPS) to accurately locate all of the road locations and culverts, and in assessing the road segments for failure. Data collected in the field are integrated into the company's Geographic Information System (GIS) and are used to prioritize road remediation and restoration efforts. In that process, we map throughout the ownership and through each sub-watershed, where we have problems and, if there are culverts, where there are fish passage problems. Road features can be displayed based on database attributes, such as treatment immediacy. The crossings GIS data layer can be queried to identify all sites that meet certain criteria. For instance, the crossings data layer can be queried for all sites that have more than 100 cubic yards of controllable volume.

In the coastal streams of California, and probably throughout the entire range of coastal California, the primary limiting factor for salmon is sediment. In our road inventory, we look carefully at the culverts in order to measure and quantify what exists in the way of controllable sediment. Part of this action is in response to federal mandates, not only through the Endangered Species Act (ESA), but also requirements with Total Maximum Daily Load (TMDLs). All of the streams that are within our ownership have anadromous candidate species that are already listed. Our assessment is preliminary to Federal expectations of private landowner reductions of sediment loading.

MANAGING CROSSINGS

As an example of a project we are working on, Figure 1 shows a diverted watercourse with a subsequent crossing failure on Ackerman Creek in Mendocino County, California. One of our big issues was quantifying the material to be removed. For this particular project, we did not get final approval until late September, and we were concerned about starting a fill removal late in the season. The culverts (Figure 2) will be replaced with a railroad flatcar bridge in 2001. Upstream, we plan to do graded material, probably 10–12 ft. deep, and install weirs. There are also cattle grazing in this area, so fencing and revegetation will also be necessary. By the time the whole project is complete, we estimate a cost of $143,000 to remove the pipes and put in the bridge. And all the material has to be end-hauled, loaded into a dump truck, and taken out. In addition, the graded material upstream will be removed using dump trucks; fortunately, it contains enough rock so that we can use it for road rocking on other parts of the property.

Figure 1. A diverted watercourse (Ackerman Creek, CA)

Figure 2. Three culverts which are scheduled to be replaced with a railroad flatcar bridge in 2001 (Ackerman Creek, CA)

Figure 3. A culvert and downspout installed on top of an old Humboldt crossing (Little North Fork Navarro River, CA)

In 25 years of doing restoration projects, I've learned that all the best forestry ideas already exist, and basically what we are doing is reversing history. Figure 3 shows an old Humboldt log crossing that collapsed on the Little North Fork of the Navarro River in Mendocino County. The previous forester found water flowing over it, so he installed a culvert. Our decision has been to remove both the culvert and the Humboldt crossing, and reunite the stream with another feeder stream by means of a railroad flatcar bridge. In the coastal regions of California, using culverts is almost a guarantee for failure. We do use them occasionally and even sometimes re-install them, but this is rare because streams in California really flash, moving huge amounts of bed load, and we have found it impossible to size for the kind of catastrophic events and landslides that occur in our coastal mountains. So heavy maintenance of culverts is inevitable, and we want to prevent that.

As we are doing assessments, we also consider non-fishery issues. In one case, we had an obligation to maintain an historical structure (Figure 4), which was all redwood and not apt to rot or collapse. Our risk assessment considered the historic value of keeping this old bulkhead in place, so we chose not to remove the old redwood logs, and it gave plenty of fish passage.

Figure 4. Degree of crossing removal may involve assessment of more than just fisheries issues

Armoring

The simplest method is removing crossings and then using logging, or other available material, to "armor" what has been moved out of the crossing to prevent erosion.

Figure 5. Tractor crushed logging debris at road or skid trail crossings

Tractor-crushed debris works perfectly (Figure 5), eliminating the need for straw bales or other imported material. One excavated crossing was an old log crossing. We incorporated the wood back into the design of the removal, leaving large woody debris (LWD) in the area of influence, although not within the stream zone itself (Figure 6).

Figure 6. Incorporating large woody debris

There are also more expensive methods of working with crossings. Not every crossing do we want to remove; with some, we want only to eliminate the ability of sediment to get into the stream system. A very simple approach is to lay down good clean gravel (Figure 7). The same range of price for material and equipment occurs for us as elsewhere. Clean rock gravel can run $8–10 per ton. It's easy to find in Mendocino County, but in Santa Cruz County for instance, it might have to be hauled 60 to 70 miles. The point source for material is important. It may be more beneficial in an area where rock is scarce to put the road to bed under vegetation and not allow traffic on it.

Figure 7. Rocked surface at crossing

Rolling Dips

Rolling dips can be substituted for cross drains on roads that are not used year-round (Figure 8). To construct a rolling dip, an inexperienced operator can spend 3–5 hours using a bulldozer to rough one out, but an experienced operator can install one in half an hour.

Rolling dips are used in a variety of ways. One is to sheet water off the road; a second is to minimize the use of side drain culverts. At other times, where an existing culvert is a good solid pipe and not decomposing, we install a dip as a backup because of the flashing nature of our streams.

Therefore, we assess all of our culverts, and where there is no backup option, we install a rolling dip just below where the culvert might fail. The water then would go into the rolling dip and across the road where we direct it off on an armored down spout, or an energy dissipater at the indigenous soil/nick point of the fill. With that armored, if a failure occurs, we're less likely to lose the entire fill.

Figure 8. A rolling dip draining surface runoff onto a fillslope covered with strawmulch (Soda Springs Road, Albion River Watershed, CA)

Building a rolling dip may take 3–4 hours to excavate and put down the armoring, depending on the depth of the fill. In some cases, I've had to use excavators and large rip rap that runs $10–12 a ton with the project taking 1–2 hours to do the hard facing. However, it is a very simple safeguard for forest roads.

In other circumstances, we're increasingly using complete no-culvert-type roads with rolling rock line dips that can be driven over by a pickup truck or a fire truck for emergencies (Figure 9). This has eliminated our need for continual maintenance and inspection. One consideration with rock armor crossings is to make them wide enough to drive through; if not, the only access will be by ATV. When we're going to use this road again for logging, we'll fill the dips with straw, bury them with dirt, and drive over them while logging, and then dip them out when we're done. Sometimes we

Figure 9. Example of a rock-armored crossing

put these in on our logging roads where the log trucks can drive right out of them.

The best kind of rock to use for dips is regular pit-run rock because the variety of sizes tends to lock together and not move if it is compacted well with a roller compactor or a tractor. Then depending on the "flashiness" of the stream, we may install a cross log or some larger riprap to hold back that rock.

A rolling rock dip can be installed in two hours of tractor time; cost also depends on how far the rock must be hauled. The cost of hauling may include 1–2 dump trucks of rock and another hour of tractor time to roll it and compact it.

Other parts of these restoration projects and culvert removals start escalating in cost if the area has steep ground or requires a large amount of fill. Also, an inexperienced operator will be tempted to make it look nice with each pass of the bucket, using costly time, when what is needed is to haul dirt as fast as possible with some minimal beautification at the end. The equipment runs anywhere from $100 to $150 per hour with an operator, so we want to get the most out of it. In crossing removals, an excavator that has relatively long reach is helpful. Another handy item is having a thumb on a minimum 3-ft bucket, so the operator can grab woody debris and move it around.

Bridges

A note on arched culverts: we have completely abandoned their use. The ones on the property cause us nothing but grief. Any time river systems move large amounts of material as they do in California, the foundation of an arched pipe must be down to bedrock or they are constantly undermining and failing. We've shifted almost entirely to bridge installations on our major streams. Where we had culverts, we are putting in railroad flatcar bridges (not boxcar). A boxcar

Figure 10. Frame bridge

Figure 11. Steel-decked bridge

cannot carry nearly the load of a railroad flatcar with its big deep I-beam, although boxcars are good for really short spans.

Bridge Installation

Figure 10 shows a frame bridge and Figure 11 shows a steel-decked bridge. The latter costs a bit more but provides a ready-made running surface. Installation involves a fairly simple method, normally requiring two pieces of equipment: a bulldozer with a winch and, on the other end, an excavator or a loader that holds the bridge back so it can

Figure 12. Example of a railroad flatcar bridge installed with riprap along the channel

be suspended. The bulldozer pulls across the cavern to be spanned instead of pulling down to the creek and up the other side and tearing everything up. We suspend these with the bulldozer and then set them in place on either side. However, this process is complicated if the site is on a bend.

There are several different ways of doing this type of construction. We can pull them in to bare dirt, which is simplest and cheapest, but won't meet most specifications. However, we do this in the woods sometimes when we're putting one in temporarily. If we're making a permanent installation, sometimes we'll square off a redwood log, one that's not going to rot, and set it on a log curve, which works very well. If the span is so great that the bridge can't cover the span, say 90 feet, we'll build bents of steel, which cost $2,500–$5,000, and back them with pressure-treated material. (Note: The maximum footage out of flatcars is 90 ft, usually 50–90 ft.)

But pulling the bridge across sometimes requires a bit of ingenuity. Renting a crane is an option; they can handle these bridges. However, in forest settings the roads are so narrow and winding that we often cannot get a crane in to lift the bridge. Sometimes the bridge has to be offloaded at the highway and then hauled miles to the location. Forest roads tend to be very windy. Log trucks are made to negotiate those roads, but 90-ft. railroad flatcar bridges won't go around those curves so they have to be pushed and pulled.

There are ways of installing bridges when it's only possible to have equipment on one side of the stream. The easiest is to bring in a crane, but as mentioned above, that is not always possible. In one case we could not get a crane in, so we used an old logging idea. It took two men one day to build it, using a gin pull, a redwood log, and an 800-lb. block that the bull line of the cat is run through. It was then attached to the bridge to get sufficient width to bring it across so we could set it on the bend. That's rather a lost art these days. That kind of engineering in the forest is going by the wayside, but there are still people around who do it. To get the dozer across, we built a road from the other end of the ranch to that point and we walked it around. We used that same technique when we could not get a dozer on the other side to pull. We built an A-frame in the middle of the stream and we did it all from one side with lines running across and back. It costs a little more for set-up this way, but never more than two man-labor days.

Bulkheads

Another aspect of bridge construction is often necessary use of bulkheads. The steel frame in Figure 13 cost around $5,000 to build; it was backed with pressure-treated 3x12 or 4x12 Douglas fir. The complete bent ran about $6,500. Then the approach and the back filling of compacted material were added in. By the time this bridge was in place with a deck on it and bents in place, the total was $30,000. Fortunately, we didn't have to build another bulkhead on the other side.

Figure 13. Example of bridge installation bulkheading

In some places on our property, there is no way to tell where the old channel was because so much disruption has happened in the watershed. Often, we will armor the lower base of a crossing removal before we put the flatcar in, as insurance that we won't get a lot of back cutting and then undermining. The riprap here was ungrouted and backed with fabric. In the rolling rockline dip method discussed above, we lay down fabric before we put the riprap down.

Note: We've returned to several of these bulkheads and planted willow. In the coastal regions of California, things re-vegetate so fast that it will be re-vegetated in two or three years.

CROSSING CONSIDERATIONS

In my experience, I have found the following to be important considerations when working on a crossing project and developing costs:

- Time starts and stops at the loading area. If the work location requires trucks to drive a long way in and out, it may be necessary to pay travel time. Some truckers charge extra for hauling riprap.
- Traffic and road conditions matter. When estimating truck times on maintained main line or secondary roads, 3 minutes per mile is average.
- Loading time varies (7–15 minutes). The distance from the truck staging area to the loading area should be kept as short as possible.
- Semi end dumps need a flat level spot to dump.
- The 28´ to 32´ semi trailers are most suitable for use on logging-type roads.
- Riprap weighs about 2,700 lbs/cu yd.
- Pit run rock weighs about 2,600 lbs/cu yd.
- When estimating hauling costs for pit run rock or excavated earth, be sure to consider the swell of the material. We use a 25% swell factor.

- When ordering trucks, be sure to communicate the type of material to be hauled and the type of road to be used. Many highway dump trucks are not suitable for larger rock or logging type roads. If the wrong type of truck shows up on the job and the driver refuses to haul, you will lose a day of production.

- Riprap is classified by weight groups. For example, the weight group of Head Stone is approximately 1 cubic foot or 100 pounds. The weight group of 1/4 ton is approximately 5 cubic feet in size. This weight grouping continues on up to Rocks, which will weigh many tons per rock. When hauling the larger sizes, care must be used to place the rocks in the dump box in a manner that will let them dump out without jamming in the box. This need will often result in loads that weigh less than the truck's capacity.

CROSSING PROJECT AVERAGE COSTS

The following provides an average range for costs incurred in crossing projects. It should be noted that costs will often vary by location and availability of equipment, materials, and labor.

Hauling Costs

- Bobtail dumps: Most dump boxes on this size truck are designed to haul 3–15 cubic yards. Legal loads vary from 2–6 tons. Rate per hour: $50–55.

- 10 wheel dumps: Most dump boxes on this size truck can haul 10–12 cubic yards or 12-ton loads legally. If the truck does not need to enter the highway and the haul road has been graded, 15-ton loads are possible. Rate per hour: $68.

- Semi end-dumps: Semi dump trailers vary in length from 28´ to 40´. Most are designed to haul 20 cubic-yard loads. A 28´ trailer can haul approximately 17 tons legally; a 40´ trailer, approximately 24 tons. If the truck does not need to enter the highway and the haul road has been graded, 28-ton loads are possible. Rate per hour: $75.

Rock Costs

- 3/4 minus = $8.50 per ton on board truck.
- 1 1/2 rock = $8.50 per ton on board truck.
- 6˝–12˝ cobble rock = $11.75 per ton on board truck.
- Rip rap = $15.00 per ton on board truck.
- Rock pit development costs vary; however, $1.00–$1.50 per ton is the average for pre-drilling earthwork.
- Rock drilling and blasting cost average = $2.25 per yard with 5,000 cubic yard minimum.

Railroad Flatcar Costs

- 53´ steel frame = $10,000–$12,000 FOB dealer's yard.
- 62´ steel frame = $12,000–$15,000 FOB dealer's yard.
- Cost to deck 53´–62´-ft. cars with 12´ wide wooden deck: labor = $2,500, materials = $2,500.
- 85´–89´ steel-decked cars = $15,000–$20,000. The width on the deck is about 8´6˝.

Excavator Costs

- 30,000 lb size class:
Rental per hour = $85–$125
Bucket capacity = 0.38–0.98 cubic yards
Digging depth of 18 ft.
- 40,000 lb size class:
Rental per hour = $85–$145
Bucket capacity = 0.88–1.42 cubic yards
Digging depth of 19 ft.
- 50,000 lb size class:
Rental per hour = $100–$175

Bucket capacity = 0.38–1.88 cubic yards
Digging depth of 21 ft.

Dozer Costs

- D4 size = hourly $72 and up
- D6 size = hourly $65 and up
- D7 size = hourly $75 and up
- D8 size = hourly $90 and up

Crane Costs

- Rental per hour = $150 and up
- The crane may require support crew and equipment that add to the cost.
- Larger railcars may require 2 cranes to swing into place.

Sheet Piling

- Sheet piling can be used for bridge abutment construction when the maximum stream channel width possible is needed.
- Sheet piling can be purchased in various lengths, up to 30´.
- It can be installed using the bucket of an excavator to push it into the ground.
- Approximate cost is $5.50 (plus tax and freight) per square foot, for a medium gage steel pile.

Road Paper

- 8 oz. non-woven filter fabric in 12.5´ x 360´ rolls is $380 per roll (plus tax and freight). If you buy the larger size rolls, the cost per square foot is somewhat lower; however, the cost of handling them in the woods is greater as they are awkward and heavy.